

REMARKS

In accordance with the foregoing, claim 16 has been cancelled. Claims 1-15 are pending. Claims 1-8 and 11-15 are under consideration.

(I) Amendment to the claims

Claim 16 has been canceled.

(II) Summary

The present invention relates to a polymer foam. The primary reference cited by the Examiner, Karande, describes a polymer foam on page 11. Important characteristics for a polymer foam include flexibility at a variety of temperatures and the ability to act as a shock absorber (low-impact resilience).

The Examiner admits that Karande does not disclose three claimed properties. The Examiner cites Hawkins et al. for the deficiencies in Karande. Hawkins et al. is not specifically concerned with a polymer foam. Hawkins et al. teaches that it is known to manipulate two of the claimed properties to achieve better tensile strength and better elongation. However, tensile strength and elongation are not properties that one seeks for a polymer foam. In addition, one of the properties (peak of loss tangent) is not mentioned by either Karande or Hawkins.

(III) The state of the art and the features and potential advantages of the proposed polymer foam

Before specifically addressing the Examiner's rejections in the outstanding Office Action, it is believed that the following background information should be considered in order to shed a proper light on the development of the proposed polymer foam and the advantageous features thereof.

As described in the present specification under "Prior Art", with respect to a shaped article containing a hydrogenated copolymer which is obtained by hydrogenating an unhydrogenated copolymer comprising vinyl aromatic monomer units and conjugated diene monomer units, it is desired to impart thereto flexibility, low temperature characteristics (such as flexibility at low temperatures) and shock-absorbing property (low impact resilience), so that the shaped article can be advantageously used as a shock-absorber or the like.

In this situation, the present inventors have made extensive and intensive studies with a view toward developing a shaped article containing the above-mentioned hydrogenated copolymer, wherein the shaped article exhibits excellent properties with respect to flexibility, low

temperature characteristics (such as flexibility at low temperatures) and shock-absorbing property (low impact resilience). As a result, it has unexpectedly been found that such an excellent shaped article can be realized by a polymer foam as defined in claim 1 of the present application. For easy reference, claim 1 of the present application is reproduced below.

"1. A polymer foam comprising a plurality of cells defined by cell walls which constitute a polymer matrix,
 said polymer matrix being comprised of:
 5 to 100 parts by weight, relative to 100 parts by weight of the total of components (A) and (B), of (A) a hydrogenated copolymer obtained by hydrogenating an unhydrogenated copolymer comprising vinyl aromatic monomer units and conjugated diene monomer units, said unhydrogenated copolymer containing at least one copolymer block S which is comprised of vinyl aromatic monomer units and conjugated diene monomer units and which has a vinyl bond content of from 5 % to less than 40 % as measured with respect to conjugated diene monomer units, and
 95 to 0 part by weight, relative to 100 parts by weight of the total of components (A) and (B), of (B) at least one polymer selected from the group consisting of an olefin polymer other than said hydrogenated copolymer (A) and a rubbery polymer other than said hydrogenated copolymer (A),
 said hydrogenated copolymer (A) having the following characteristics (1) and (2):
 (1) said hydrogenated copolymer (A) has a content of said vinyl aromatic monomer units of from more than 40 % by weight to 60 % by weight, based on the weight of said hydrogenated copolymer (A), and
 (2) at least one peak of loss tangent ($\tan\delta$) is observed at $-40\text{ }^{\circ}\text{C}$ to lower than $-10\text{ }^{\circ}\text{C}$ in a dynamic viscoelastic spectrum obtained with respect to said hydrogenated copolymer (A),
 said polymer foam having a specific gravity of from 0.05 to 0.5."

As seen from claim 1 reproduced above, the polymer foam of the present invention contains a hydrogenated copolymer (A) obtained by hydrogenating an unhydrogenated copolymer comprising vinyl aromatic monomer units and conjugated diene monomer units, wherein the unhydrogenated copolymer contains at least one specific copolymer block S. The hydrogenated copolymer (A) has the following important features (I), (II) and (III):

(I) The copolymer block S (contained in the unhydrogenated copolymer from which the hydrogenated copolymer (A) is obtained by hydrogenation) is comprised of vinyl aromatic monomer units and conjugated diene monomer units and has a vinyl bond content of from 5 % to less than 40 % as measured with respect to conjugated diene monomer units.

(II) The hydrogenated copolymer (A) has a content of the vinyl aromatic monomer units of from more than 40 % by weight to 60 % by weight, based on the weight of the hydrogenated copolymer (A).

(III) At least one peak of loss tangent ($\tan\delta$) is observed at $-40\text{ }^{\circ}\text{C}$ to lower than $-10\text{ }^{\circ}\text{C}$ in a dynamic viscoelastic spectrum obtained with respect to the hydrogenated copolymer (A).

By virtue of the above-mentioned features (I) to (III), the polymer foam may exhibit excellent properties with respect to flexibility, low temperature characteristics (such as flexibility at low temperatures) and shock-absorbing property (low impact resilience). This is unexpected. No prior art reference teaches or suggests the polymer foam of the present invention and the unexpected effects achieved thereby.

Feature (I) (i.e., the feature that the copolymer block S is comprised of vinyl aromatic monomer units and conjugated diene monomer units and has a vinyl bond content of from 5 % to less than 40 % as measured with respect to conjugated diene monomer units) is important for enhancing the shock-absorbing property (low impact resilience) of the polymer foam. This is suggested from the following description of the present specification:

“With respect to the vinyl bond content of the conjugated diene monomer units of the copolymer block comprised of vinyl aromatic monomer units and conjugated diene monomer units in the base unhydrogenated copolymer, there is no particular limitation; however, it is preferred that the vinyl bond content is from 5 % to less than 40 % (hereinafter, the vinyl bond content means the total content of the 1,2-vinyl bond and 3,4-vinyl bond with the proviso that, when only 1,3-butadiene is used as the conjugated diene monomer, the vinyl bond content means the content of the 1,2-vinyl bond). From the viewpoint of the low impact resilience and handling property (anti-blocking property) of the polymer foam, the vinyl bond content is more preferably from 5 to 35 %, still more preferably from 8 to 30 %, still more preferably from 10 to 25 %.” (emphasis added) (see page 32, lines 4-19 of the present specification)

Also, feature (II) (i.e., the feature that the hydrogenated copolymer (A) has a content of the vinyl aromatic monomer units of from more than 40 % by weight to 60 % by weight, based on the weight of the hydrogenated copolymer (A)) is important for enhancing the polymer foam with respect to flexibility and shock-absorbing property (low impact resilience). This is suggested from the following description of the present specification:

“The content of the vinyl aromatic monomer units in the hydrogenated copolymer (A) is from more than 40 % by weight to 60 % by weight, based on the weight of the hydrogenated copolymer (A). From the viewpoint of flexibility and shock-absorbing property, the content of the vinyl aromatic monomer units in the hydrogenated copolymer (A) is preferably from 43 to 57 % by weight, more preferably from 45 to 55 % by weight.” (emphasis added) (see page 19, line 18 to page 20, line 1 of the present specification)

Further, feature (III) (i.e., the feature that at least one peak of loss tangent ($\tan\delta$) is observed at $-40\text{ }^{\circ}\text{C}$ to lower than $-10\text{ }^{\circ}\text{C}$ in a dynamic viscoelastic spectrum obtained with respect to the hydrogenated copolymer (A)) is essential for achieving a good balance of flexibility, low temperature characteristics (such as flexibility at low temperatures) and shock-absorbing property (low impact resilience) in the polymer foam. This is apparent from the following description of the present specification:

“The presence of at least one peak of loss tangent in the range of from $-40\text{ }^{\circ}\text{C}$ to lower than $-10\text{ }^{\circ}\text{C}$ is essential for achieving a good balance of flexibility, low temperature characteristics and shock-absorbing property (low impact resilience) in the polymer foam.” (see page 20, line 24 to page 21, line 4 of the present specification)

The effects of the proposed polymer foam, which are achieved by the use of the hydrogenated copolymer (A) having the above-mentioned features (I) to (III), are substantiated in the working examples (i.e., Examples 1-8) of the present application. Although this is already explained in the Applicants' response filed on November 21, 2007 (see page 9, line 14 to page 13, line 18 of the “Amendment” filed on November 21, 2007), the explanation is repeated below.

In Examples 1-8 of the present application, polymer foams containing hydrogenated copolymers are produced, and the properties of the polymer foams are measured and evaluated (see page 98, lines 10 to page 103, line 8 of the present specification; and Table 1 appearing at page 104 of the present specification). As the hydrogenated copolymers, polymers 1 to 4 are used in Examples 1-8. The characteristics of polymers 1 to 4 are shown in Table A appearing at page 11 of the “Amendment” filed on November 21, 2007. For easy reference, Table A is reproduced below:

Table A

	Block configuration	Vinyl bond content (%)	Styrene monomer unit content (wt. %)	Peak of loss tangent ($^{\circ}\text{C}$)
Polymer 1	H-S-H	20	52	-15
Polymer 2	H-S-H	22	46	-25
Polymer 3	H-S-H	20	52	-15
Polymer 4	H-S-H	20	52	-15

Notes:

(1) “Block configuration” means the block configuration of the unhydrogenated block copolymer used for producing the hydrogenated copolymer. In these block configurations, each H independently represents a styrene polymer block and each S independently represents a styrene/butadiene copolymer block.

(2) "Vinyl bond content" means the vinyl bond content of the copolymer block S (as measured with respect to butadiene monomer units) contained in the unhydrogenated block copolymer.

As seen from Table A above, each of polymers 1 to 4 satisfies all of the above-mentioned features (I) to (III). Specifically, the copolymer block S (styrene/butadiene copolymer block) contained in the unhydrogenated block copolymer used for producing polymer 1, 2, 3 or 4 has a vinyl bond content of from 20 to 22 % as measured with respect to butadiene monomer units, which is within the range (from 5 % to less than 40 %) recited in feature (I). Also, each of polymers 1 to 4 has a styrene monomer unit (vinyl aromatic monomer unit) content of from 46 to 52 % by weight, which is within the range (from more than 40 % by weight to 60 % by weight) recited in feature (II). Further, in a dynamic viscoelastic spectrum obtained with respect to polymer 1, 2, 3 or 4, a peak of loss tangent ($\tan\delta$) is observed at a temperature of from -25 to -15 °C, which is within the range (from -40 °C to lower than -10 °C) recited in feature (III).

By the use of such hydrogenated copolymers having features (I) to (III), the polymer foams produced in Examples 1-8 have excellent properties, as explained below.

As shown in Table 1 appearing at page 104 of the present specification, the polymer foams produced in Examples 1-5 exhibit excellent properties with respect to flexibility, low temperature characteristics (such as flexibility at low temperatures) and shock-absorbing property (low impact resilience).

Also, the polymer foams produced in Examples 6-8 have excellent properties as comparable to those of the polymer foam obtained in Example 1 (see page 102, lines 11-13 and 21-23, and page 103, lines 6-8 of the present specification). Therefore, the polymer foams produced in Examples 6-8 exhibit excellent properties with respect to flexibility, low temperature characteristics (such as flexibility at low temperatures) and shock-absorbing property (low impact resilience).

As apparent from the above, the working examples (i.e., Examples 1-8) of the present application show that, by virtue of the hydrogenated copolymer (A) having the above-mentioned features (I) to (III), there can be obtained a polymer foam having excellent properties with respect to all of flexibility, low temperature characteristics (such as flexibility at low temperatures) and shock-absorbing property (low impact resilience).

In this connection, it should be noted that such an excellent polymer foam cannot be obtained if a hydrogenated copolymer having the above-mentioned features (I) to (III) is not

used. On this point, an explanation is given below, with reference to Comparative Example 1 of the present application.

In Comparative Example 1, a polymer foam is produced without use of a hydrogenated copolymer having the above-mentioned features (I) to (III) (see page 103, lines 10-18 of the present specification; and Table 1 appearing at page 104 of the present specification).

As shown in Table 1 appearing at page 104 of the present specification, the polymer foam obtained in Comparative Example 1 has poor properties with respect to low temperature characteristics (such as flexibility at low temperatures). Specifically, the polymer foam obtained in Comparative Example 1 exhibits a hardness of 69 at a temperature of -10 °C, which is very high as compared to the values (from 47 to 56) obtained with respect to the polymer foams produced in Examples 1-5. This shows that the polymer foam obtained in Comparative Example 1 has poor flexibility at -10 °C as compared to the case of any of the polymer foams of Examples 1-5.

(IV) Rejections based on prior art

In the outstanding Office Action, claim 1-4, 6 and 13-16 are rejected under 35 U.S.C. 102(a) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Karande et al. [WO 02/068529 A2] (hereinafter referred to as "Karande '529"), and evidenced by Hawkins et al. [US 3935176] (hereinafter referred to as "Hawkins '176") (see item 4 appearing at pages 2-4 of the Office Action). In connection with the rejection of claims 1, 6 and 14, the Examiner states as follows:

"Karande's invention relates to an article prepared from a blend comprising 0 to 50 wt% of hydrogenated random styrene butadiene copolymer (S block) [pp. 3]. Foamed articles are used for various cushions and footwear including shoe soles, etc. [pp. 11].

For claims 1, 6 and 14, Karande is silent about 1) the composition limitations (i.e., the weight ratio between the styrene and butadiene monomers, the vinyl bond content with respect to diene monomer) of the hydrogenated component (A) (hydrogenated S block), and 2) the physical limitations (peak loss tangent (mechanical property) and the specific gravity (density)) of the foam. However, regarding 1), Hawkins' invention relates a hydrogenated random copolymer of a conjugated diene and vinyl aromatic compound [abstract]. Variations in the vinyl content of the conjugated diene portion of the unhydrogenated copolymer also affect the tensile strength, there being a steady decrease in tensile strength as vinyl content is increased. By adjustment of degree of hydrogenation (i.e. varying

mole % saturation), the percent vinyl aromatic content and the vinyl content of the conjugated diene portion, a wide variety of properties in the final material may be obtained. Fig. 1 shows that the optimum properties are specifically obtained by adjusting the variables of monomer ratios and vinyl bond content, i.e., these are result-effective variables for optimal mechanical properties for various end uses. Since Karande teaches general the same subject matter (i.e., foam cushions prepared from a blend of hydrogenated random styrene butadiene copolymer) for the same end uses as the claimed invention, absent any unexpected results, workable ranges of composition variables are deemed to be either anticipated, or obvious routine optimizations to one of ordinary skill in the art, as evidenced by Hawkins, motivated by the desire to provide the same end use requirements. Similarly, regarding 2), since the peak loss tangent and density of the foam is result effective to the cushioning properties, they are also deemed to be either anticipated, or obvious routine optimizations to one of ordinary skill in the art. As to component (B), since it is optional (encompassing 0 parts by weight), it is not a required limitation by the prior art, therefore it has not been given a patentable weight." (see page 2, line 8 from bottom to page 3, line 4 from bottom of the Office Action)

The Applicants disagree with the Examiner and wish to traverse as follows.

As explained above, the polymer foam of the present invention contains the hydrogenated copolymer (A) having the above-mentioned features (I) to (III). By virtue of features (I) to (III), the proposed polymer foam may exhibit excellent properties with respect to flexibility, low temperature characteristics (such as flexibility at low temperatures) and shock-absorbing property (low impact resilience).

Karande '529 is directed to a fabricated article prepared from a blend containing a substantially random ethylene/propylene/vinyl aromatic monomer interpolymer and a hydrogenated random styrene/diene copolymer (see page 3, lines 3-29 of Karande '529). The Examiner thinks that the hydrogenated random styrene/diene copolymer corresponds to the hydrogenated copolymer (A) used in the present invention.

However, actually, Karande '529 has no teaching or suggestion about the hydrogenated copolymer (A) having features (I) to (III). Also, Karande '529 does not teach or suggest that a polymer foam exhibiting the above-mentioned excellent properties can be obtained by using the hydrogenated copolymer (A).

Regarding feature (III) (specific range of peak of loss tangent ($\tan\delta$)), the Examiner states that the peak of loss tangent is result effective to the cushioning properties. However, Karande '529 has no such teaching or suggestion. Karande '529 does not refer to the peak of loss tangent of a polymer, let alone the effect achieving by controlling the peak of loss tangent within a specific range.

Hawkins '176 discloses a thermoplastic elastomeric material comprising a hydrogenated copolymer obtained by hydrogenating a random copolymer of at least one conjugated diene and at least one vinyl aromatic compound (see Abstract of Hawkins '176). As the Examiner points out, Hawkins '176 has an argument on the content of the vinyl aromatic compound or the vinyl content of the diene portion.

However, the argument in Hawkins '176 is made from the viewpoint of improving the physical properties (such as tensile strength and elongation set) of a thermoplastic elastomeric material, and is never made from the viewpoint of improving the properties of a polymer foam discussed in the application, such as flexibility, low temperature characteristics (such as flexibility at low temperatures) and shock-absorbing property (low impact resilience). This is apparent, for example, from the following description of Hawkins '176:

"We have found that the mole % saturation, the mole % vinyl aromatic content of the copolymer and the mole % vinyl content of the diene portion have a profound effect on the physical properties of the resultant material e.g. tensile strength and elongation set." (emphasis added) (see column 3, lines 15-19 of Hawkins '176)

Also, Hawkins '176 does not refer to the peak of loss tangent of a polymer, let alone the effect achieved by controlling the peak of loss tangent within a specific range.

Therefore, Hawkins '176 has no teaching or suggestion about obtaining a polymer foam having excellent properties as defined in the present invention. Thus, a skilled person would not have been motivated to use Hawkins '176 in combination with Karande '529 so as to obtain an excellent polymer foam as defined in the present invention.

Further, even if Hawkins '176 is combined with Karande '529, a person skilled in the art cannot arrive at the present invention, because neither Hawkins '176 nor Karande '529 teach or suggest that an excellent polymer foam can be obtained by using the hydrogenated copolymer (A) having the above-mentioned features (I) to (III). It should be emphasized that neither Karande '529 nor Hawkins '176 teaches or suggests that feature (III) (i.e., the feature that at least one peak of loss tangent ($\tan\delta$) is observed at $-40\text{ }^{\circ}\text{C}$ to lower than $-10\text{ }^{\circ}\text{C}$ in a dynamic viscoelastic spectrum obtained with respect to the hydrogenated copolymer (A)) is essential for achieving a good balance of flexibility, low temperature characteristics (such as flexibility at low temperatures) and shock-absorbing property (low impact resilience) in the polymer foam.

From the above, it is apparent that the polymer foam of claim 1 of the present application has novelty and unobviousness over Karande '529, even if Hawkins '176 is taken into consideration.

Now that the novelty and unobviousness of claim 1 over the prior art has been established, the novelty and unobviousness of the remaining claims over the prior art is also apparent.

(V) Supplementary argument on the novelty and non-obviousness of claims 11 and 12 based on prior art

The Applicants believe that the above argument has already overcome the prior art rejections of all of the pending claims. However, in connection with the rejection of claims 11 and 12 over Karande '529, the Applicants wish to make the following supplementary argument.

Claim 11 is directed to the polymer foam of claim 1 or 2, wherein the rubber polymer as component (B) is limited to a specific polymer. In claim 12, the rubber polymer as component (B) is further limited.

The Examiner states that "Karande discloses that the blend may include styrenic block copolymers, such as styrene-butadiene-styrene, etc., in an amount up to 50 wt% [pp.3 and 9]" (see page 5, lines 5-4 from bottom of the Office Action). However, the "styrenic block copolymer" referred to by the Examiner is an example of component (C) of the blend recited in Karande '529 (see page 3 of Karande '529), which, according to the Examiner, corresponds to the component (A) used in the present invention. The Examiner fails to explain how the component (B) recited in present claim 11 or 12 is anticipated by or obvious over Karande '529.

Hawkins '176 also does not teach or suggest the combination of the component (A) with the component (B) as defined in present claim 11 or 12.

Thus, claim 11 and 12 are not taught or suggested by Karande '529, even if Hawkins '176 is taken into consideration.

(VI) Election of the species

In the outstanding Office Action, the Examiner does not raise the issue on the election of the species. Since the Examiner states that "Applicants' amendments and remarks filed on 1/23/2009 have been entered. . . . In response to the amendments, the grounds of rejection

have been updated as set forth below. Rejections not maintained are withdrawn." (see page 2 of the Office Action), the Applicants understand that their argument made in page 12, item (II) of the "Submission with Request for Continued Examination" filed on January 23, 2009 has been accepted.

(VII) Conclusion

From the foregoing, it is firmly believed that the all of the Examiner's rejections have been overcome. Early and favorable action is respectfully solicited.

There being no further outstanding objections or rejections, it is submitted that the application is in condition for allowance. An early action to that effect is courteously solicited.

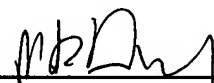
Finally, if there are any formal matters remaining after this response, the Examiner is requested to telephone the undersigned to attend to these matters.

If there are any additional fees associated with filing of this Amendment, please charge the same to our Deposit Account No. 19-3935.

Respectfully submitted,

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